IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Applicants:	Yoshiaki Mori, et al.	Art Unit:	1756
Serial No.:	10/026,286	Examiner:	Daborah Chacko Davis
Filed:	December 20, 2001	Confirmation No.:	1796
Title:	Pattern Forming Method and Apparatus Used for Semiconductor Device, Electric Circuit, Display Module, and Light Emitting Device		

Amended Brief on Appeal Under 37 CFR § 41.31

Sir:

INTRODUCTION

This Amended Brief on Appeal is being filed in response to the Notification of Non-Compliant Appeal Brief mailed October 2, 2007. The present amendments better identify all arguments under a separate heading for each ground of rejection on appeal, and removes all references to exhibits A & B previously submitted, but now excluded from the current Brief on Appeal.

Pursuant to the provisions of 37 CFR § 41.31 *et seq.*, Appellants hereby appeal to the Board of Patent Appeals and Interferences (the "Board") from the Examiner's Final Rejection dated Oct. 18, 2006. A Notice of Appeal was timely filed with the requisite fee on March 15, 2007 in accordance with 37 CFR § 1.8. This Brief on Appeal is being filed in accordance with 37 CFR §41.37 and the Director is authorized to charge the requisite fees (37 CFR § 41.37 and 41.20(b)(2)) to the undersigned's Deposit Account No.: 19-2746.

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TABLE OF AUTHORITIES

N/A

REAL PARTY IN INTEREST

The parties listed in the caption of the brief have assigned all interest in the application from which the instant appeal is taken to:

Seiko Epson Corporation
4-1 Nishishinjuku 2-chome
Shinjuku-ku, Tokyo
Japan

Thus, Seiko Epson Corporation is the real party in interest.

RELATED APPEALS AND INTERFERENCES

There are no other appeals or interferences known to the Appellants, Appellants' legal representative, or assignee that will directly affect or be directly affected by or have a bearing on the Board's decision in the instant appeal.

STATUS OF CLAIMS

Claims 1-22 are under final rejection and are the subject of this appeal.

Claims 23-64 are withdrawn from consideration.

STATUS OF AMENDMENTS

No amendment has been filed subsequent to the final rejection.

SUMMARY OF CLAIMED SUBJECT MATTER

In the following, the format of the claims will be maintained to allow easy reference to the actual claim language. References to "Fig." numbers and reference characters are references to drawings of the subject application, and references to paragraph number, page number, and/or line numbers are references to the specification of the subject application.

Independent Claim 1

The present invention, as recited in independent Claim 1, is directed to a pattern forming method (Fig. 10, para. 185-188 and/or Figs. 18(1)-19(3) para. 220-334) characterized by:

forming a mask having pattern-forming openings on a workpiece surface (S130), and then supplying (S132) and solidifying (S133) an electrically

conductive liquid pattern material (para. 187) in the pattern-forming openings of the mask.

> **[Para. 0019]** To achieve the above object, a pattern forming method according to the present invention is characterized by forming a mask having pattern forming openings on a workpiece surface, and then supplying and solidifying a liquid pattern material in the pattern forming openings of the mask. An organometallic compound solution or a solution of a powder of an inorganic material dissolved in solvent can be used as the liquid pattern material.
>
> **[Para. 00187]** Next, a liquid pattern material 312 comprising an organometallic compound is supplied by a specific-volume discharge device such as the print head of an inkjet printer to the pattern forming openings in the mask processed for hydrophobic as described above. By heating the workpiece 20 to a specific temperature by means of a heater built in to the table on which the workpiece 20 is placed, supplying the liquid pattern material 312 to the openings and heating and solidifying the liquid pattern material are performed at the same time, and the pattern forming process ends with step S132.

Independent Claim 2

The present invention, as recited in independent Claim 2, is directed to a pattern forming method (Fig. 8, para. 175-178) characterized by:

a mask forming process (S110) for forming a mask having pattern-forming openings on a workpiece surface;

a pattern material supplying process (S112) for supplying a liquid-pattern material to the pattern-forming openings while also drying the liquid-pattern material (para. 117);

a process for removing the mask from the workpiece (S115); and

an annealing process for annealing dried solute of the liquid-pattern material (S116).

> **[Para. 00173]** ... Moreover, because the liquid pattern material 312 is annealed in the pattern annealing process *after* drying in the pattern drying process in this first pattern forming method, the formation of internal voids and the *formation of deformation recesses in the formed pattern surface when the liquid pattern material 312 solidifies can be prevented.*
>
> **[Para. 00178]** As in the first embodiment of a pattern forming method described above, a mask removal process (step S115) and pattern annealing process in step S116 are *applied in order*. These steps are also the same as in the previous embodiment.
>
> **[Para. 00277]** ... if the carbonization temperature of the resist film is lower than the annealing temperature of the pattern film 660, *the resist film (mask 656) will carbonize during the annealing process* and removing the mask 656 will be difficult. In this case, *therefore, the mask removal process is performed first and then the pattern annealing process is*

> *performed.* It should be noted that because the carbonization temperature of PMMA, a typical resist, is approximately 260°C, and the annealing temperature of an ITO film is 500°C or higher, the resist removal process is performed first and then the annealing process is performed.

<u>Independent Claim 3</u>

The present invention, as recited in independent Claim 3, is directed to a pattern forming method (Fig. 7, para. 162-174) comprising:

a mask forming process (S100) for forming a mask having pattern-forming openings on a workpiece surface;

> **[Para. 00162] ...** this first pattern forming method first forms a mask having pattern forming openings on the surface of the workpiece. This mask forming step S100 is accomplished by the mask forming unit 100 shown in Fig. 1. More specifically, the workpiece 20 is conveyed into the mask material coating unit 110 shown in Fig. 2 of the mask forming unit 100. The photoresist 114 is then coated to and dried on the surface of the workpiece 20 by the mask material coating unit 110.
> **[Para. 00163]** The workpiece 20 is then conveyed to the mask patterning unit 120. The mask material, that is, resist film, is then exposed in the exposure unit 122 of the mask patterning unit 120 and developed in the developer unit 124. A mask having pattern forming openings in the resist film is thus formed on the surface of the workpiece 20. It should be noted that the pattern forming openings could be written directly in the resist film using an electron beam or laser.
> **[Para. 00164]** The surface of the mask is then processed for hydrophobic in the hydrophobic processing unit 200 (step S101). This mask hydrophobic process can be accomplished by generating active fluorine in the discharge unit 210 shown in Fig. 3 and supplying the active fluorine to the process chamber 218 in which the workpiece 20 is placed. It will also be noted that this workpiece surface hydrophobic process could be accomplished using an apparatus as shown in Fig. 6 to form a hydrophobic film such as a fluoropolymer film or silicon polymer film on the mask surface. When a hydrophobic process is applied according to the method shown in Fig. 3, the hydrophobic film present in the pattern forming openings is preferably removed or made hydrophilic using ultraviolet light, an electron beam, or laser, for example. Yet further, *if the mask is formed by a hydrophobic film by means of mask forming unit 150 as shown in Fig. 5 or Fig. 6, the hydrophobic mask processing step can be omitted as indicated by the dotted line in Fig. 7.*

a pattern material supplying process for supplying a liquid-pattern material to the pattern-forming openings (S102);

> **[Para. 00165]** As shown in step S102, a pattern material supply step is executed to supply liquid pattern material 312 to the pattern forming openings in the mask. This pattern material supply step is accomplished by the pattern material supply unit 300 shown in Fig. 4. ...

> **[Para. 00167]** It will be noted that supplying the liquid pattern material 312 to the pattern forming openings of the mask formed on the workpiece 20 can be done by spin coating the liquid pattern material 312, *or by*

> *using a specific-volume discharge device such as the print head of an inkjet printer.*
>
> **[Para. 00169]** Unnecessary pattern material can thus be easily removed by removing liquid pattern material 312 adhering to the mask surface at the stage at which the liquid pattern material is supplied to the pattern forming openings. *It is therefore possible to eliminate a step for removing solidified pattern material that is difficult to remove after the liquid pattern material is solidified in a drying process*, described below, and the mask can therefore be easily removed. *Note that when the liquid pattern material is supplied directly to the pattern forming openings by the above-noted specific-volume discharge device, the adherent liquid removal step of step S103 can be omitted.*

a drying process for evaporating solvent in the liquid-pattern material (S104);

> **[Para. 00170]** The liquid pattern material 312 supplied to the pattern forming openings is then dried (step S104). *Evaporating solvent contained in the liquid pattern material 312 is the main objective of drying the liquid pattern material 312*, and is normally achieved by heating the workpiece 20 to 80° to 120° C. ...

a mask removal process for removing the mask from the workpiece (S105); and

> **[Para. 00171]** A mask removal step is performed next (step S105). This mask removal step can be accomplished by immersing the workpiece 20 in a solution able to dissolve the resist film similarly to a conventional semiconductor device manufacturing process....Yet further, the mask removal step could be accomplished by ashing ....

an annealing process for annealing dried solute in the liquid-pattern material (S106).

> **[Para. 00172]** After removing the mask, solute contained in the liquid pattern material supplied to the pattern forming openings is annealed in the pattern material setting unit 500 shown in Fig. 1 to complete the solute solidification process (step S106). This pattern annealing step is normally conducted by heating the workpiece 20 to a higher temperature, such as 150°C or higher, than used in the pattern drying process.
>
> **[Para. 00173]** It is thus possible to form a specifically detailed pattern on the surface of the workpiece 20. Moreover, *because the liquid pattern material 312 is annealed in the pattern annealing process <u>after</u> drying in the pattern drying process in this first pattern forming method, the formation of internal voids and the formation of deformation recesses in the formed pattern surface when the liquid pattern material 312 solidifies can be prevented.*

Independent Claim 4

The present invention, as further recited in independent Claim 4, is directed toward a pattern forming method (Fig. 12, [00195] - [00198]) comprising:

a mask forming process (S150) for forming a mask having pattern-forming openings on a workpiece surface;

a pattern material supplying process (S152) for supplying an electrically conductive liquid-pattern material to the pattern-forming openings;

> **[Para. 00195]** Fig. 12 is a flow chart of a sixth pattern forming method according to the present invention. This pattern forming method sequentially performs the mask forming process (step S150), mask hydrophobic process (step S151), and pattern material supply process (step S152) using the same methods as in the above described embodiments.
> **[Para. 00187] …** a liquid pattern material 312 comprising an organometallic compound is supplied by a specific-volume discharge device such as the print head of an inkjet printer to the pattern forming openings…

a solidifying process (S153 and S154) for solidifying the liquid-pattern material supplied into the pattern-forming openings; and

a mask removal process (S155) for removing the mask from the workpiece after sequentially performing plural times the pattern material supply process and solidifying process.

> **[Para. 00196]** The liquid pattern material 312 supplied to the pattern forming openings is then dried and annealed as the heating and solidifying process (steps S153, S154). When this annealing process is completed, the process returns to step S152 to complete a second pattern material supply process, and the drying process and annealing process of steps S153 and S154 are then executed. These steps S152 to S154 are repeated as many times as necessary. When the last pattern annealing process is completed, the mask is removed as described above (step S155).

Independent Claim 5

Another aspect of the present invention, as recited in independent Claim 5, is directed to a pattern forming method (Fig. 17, para. 216-219) characterized by:

a mask forming process for forming a mask having pattern-forming openings on a workpiece surface (S200);

a pattern material supplying process for supplying a liquid-pattern material to the pattern-forming openings (S202);

an adherent-liquid removal process for removing liquid pattern material that adhered to the mask surface when the liquid-pattern material was supplied to the openings (S203);

a drying process for drying by evaporating solvent from the liquid-pattern material in the pattern-forming openings (S204);

an annealing process for annealing the dried solute after sequentially performing plural times the pattern material supply process, adherent-liquid removal process, and drying process (S205); and

> **[Para. 00219] …** steps S204 to S206 can be performed after repeating the pattern material supply process of step S202 and the adherent liquid removal process of step S203 the necessary number of times…

a mask removal process for removing the mask from the workpiece (S206).

Independent Claim 6

Another aspect of the present invention, as recited in claim 6, is directed to a pattern forming method (Fig. 7, and/or Fig. 9, and/or Fig. 15, para. 210-212) characterized by:

a mask forming process for forming a mask having pattern-forming openings on a workpiece surface (S180);

a pattern material supplying process for supplying a liquid-pattern material to the pattern-forming openings (S181);

a drying process for drying by evaporating solvents from the liquid-pattern material in the pattern-forming openings (S182); and

an annealing process for annealing the dried solute after sequentially performing plural times the pattern material supply process and drying process (S182).

> **[Para. 00210]** Fig. 15 is a flow chart of a ninth pattern forming method according to the present invention. This ninth pattern forming method first hydrophobic processes the surface of the workpiece 20 *in which pattern forming recesses are also formed* (step S180). Then using a discharge device such as the print head of an inkjet printer, a specific amount of liquid pattern material 312 is selectively supplied to the pattern forming recesses of the workpiece 20 (step S181). The liquid pattern material 312 is then heated and solidified (step S182) to complete pattern forming. Heating and solidifying the pattern material can be done at a relatively low temperature of 120°C or less as described above, or at a

> higher temperature. *Pattern heating and solidifying can also contain a process for drying the liquid pattern material and a subsequent annealing process.*

<u>Independent Claim 7</u>

A further aspect of the present invention, as recited in independent claim 7, is directed to a pattern forming method (Fig. 11, para. 189-194) characterized by:

a mask forming process for forming a mask having pattern-forming openings on a workpiece surface (S140);

a pattern material supplying process for supplying an electrically conductive liquid-pattern material to the pattern-forming openings (S142);

a solidifying process for solidifying the liquid-pattern material supplied into the pattern-forming openings (S143);

> **[Para. 00191] ...** When the first pattern material supply process is completed, the pattern material drying process is applied to evaporate the solvent in the liquid pattern material (step S143). ....

a solid-material removal process for removing solidified elements of the liquid-pattern material that adhered to the mask surface when the liquid-pattern material was supplied to the pattern-forming openings (S144); and

> **[Para. 00192]** Dried solids of the liquid pattern material 312 adhering to the mask surface are then removed as shown by step S144. The dried solids can also be removed as described above. Once the dried solids are removed, the process returns to step S142 and steps S142 to S144 are repeated the required number of times....

a mask removal process for removing the mask from the workpiece after sequentially performing plural times the pattern material supply process, solidifying process, and solid-material removal process (S146).

<u>Independent Claim 8</u>

The present invention, as recited in independent claim 8, is further directed to a pattern forming method (Fig. 11, para. 189-194) characterized by:

a mask forming process for forming a mask having pattern-forming openings on a workpiece surface (S140);

a pattern material supplying process for supplying a liquid-pattern material to the mask openings (S142);

a drying process for drying by evaporating solvent from the liquid-pattern material in the pattern-forming openings (S143);

a solid-material removal process for removing dried solids of the liquid-pattern material that adhered to the mask surface when the liquid-pattern material was supplied to the pattern-forming openings (S144);

an annealing process for annealing the dried solute after sequentially performing plural times the pattern material supply process, drying process, solid-material removal process (S145); and

a mask removal process for removing the mask from the workpiece (S146).

Independent Claim 9

The present invention, as recited in independent claim 9, is further directed to a pattern forming method (Fig. 16, para. 213-216) characterized by:

a mask forming process for forming a mask having pattern-forming openings on a workpiece surface (S190);

> **[Para. 00213]**: Fig. 16 is a flow chart of a tenth pattern forming method according to the present invention. As described above, the pattern forming method of this embodiment first hydrophobic processes the surface of the workpiece 20 *in which pattern forming recesses are also formed* (step S190)

a pattern material supplying process for supplying a liquid-pattern material to the mask openings (S191);

a drying process for drying by evaporating solvent from the liquid-pattern material in the pattern-forming openings (S192);

a solid-material removal process for removing dried solids of the liquid-pattern material that adhered to the mask surface when the liquid-pattern material was supplied to the pattern-forming openings (S193);

> **[Para. 00214] …** dried solids of the liquid pattern material 312 adhering to the workpiece surface are removed by CMP, plasma etching at atmospheric pressure, or other technique (step S193). …

an annealing process for annealing the dried solute (S194); and

a mask removal process for removing the mask from the workpiece after sequentially performing plural times the pattern material supply process, drying process, solid-material removal process, and annealing process (S193a).

> **[Para. 00215]** It should be noted that as indicated by the dotted line in Fig. 16, the second and subsequent pattern material supply processes can be performed after the dried solid removal process of step S193, or after the pattern material annealing process of step S194. ...

<u>Dependent Claim 10</u>

Dependent Claim 10, which depends from claim 1, recites:

wherein the mask has hydrophobic properties on at least the surface thereof for repelling the liquid pattern material (Fig. 1, 200).

> **[Para 132] ...** Fig. 1 is a schematic block diagram of a pattern forming apparatus according to a first embodiment of the present invention. As shown in Fig. 1, this pattern forming apparatus 10 has a mask forming unit 100 for forming a mask on a surface of a semiconductor substrate or other workpiece, *hydrophobic processing unit 200 for making the mask surface hydrophobic*, and pattern material supply unit 300 for supplying a liquid pattern material to a pattern forming opening disposed in the mask formed by the mask forming unit 100.

<u>Dependent Claim 11</u>

Dependent Claim 11, which depends from claim 1, recites:

wherein the mask is hydrophobic for repelling the liquid pattern material.

> **[0037]** At least the surface of the mask is preferably hydrophobic. If the workpiece is then rotated, for example, *when supplying the liquid pattern material to the pattern forming openings in the mask, liquid pattern material on the workpiece surface will move easily over the workpiece surface and into the openings*, and the liquid pattern material can thus be supplied easily, quickly, and evenly into the pattern forming openings. *Material adhering to the mask surface can also be easily removed because the mask surface is hydrophobic.*
>
> **[00141]** ... workpiece 20 itself is not made hydrophobic. ...
>
> **[00143]** As shown in Fig. 4, the pattern material supply unit 300 has an atomizer 311 for atomizing the liquid pattern material, and a shower head 310 for misting the liquid pattern material 312 atomized by the atomizer 311....

[00144] A liquid pattern material source 314 and mist gas source 316 are connected to the atomizer 311. *The liquid pattern material source 314 supplies an organometallic solution or other liquid pattern material 312* to the atomizer 311. ...

[00145] A process stage 318 with a workpiece 20 having a mask on the surface thereof placed on the process stage 318 is disposed below the shower head 310. The process stage 318 is mounted on the rotating shaft 322 of a motor 320, that is, a rotating means, and rotates freely in the direction of arrow 324. By thus rotating the process stage 318, *the pattern material supply unit 300 of this embodiment can easily supply liquid pattern material 312 to the pattern forming openings in the mask*, and unneeded liquid pattern material 312 adhering to the mask surface can be removed.

[00149] It should be noted that the adherent liquid removal means could be the motor 320. More specifically, liquid pattern material 312 adhering to the mask surface can be removed by centrifugal force by increasing the speed of the motor 320. The adherent liquid removal means could also be comprised with a cylinder, for example, for tilting the base, not shown in the figures, on which the motor 320 and process stage 318 are disposed to incline the workpiece 20 by way of the intervening base *so that the liquid pattern material 312 adhering to the hydrophobic treated surface of the mask rolls off.*

[00150] ... The pattern material supply unit 300 could also be comprised to drip the liquid pattern material onto the rotating workpiece 20 to deposit the pattern material into the pattern forming openings by spin coating.

<u>Dependent Claim 12</u>

Dependent Claim 12, which depends from claim 1, recites:

wherein the liquid-pattern material is solidified by applying heat.

Para. 0040: Heating and solidifying the liquid pattern material can as necessary comprise a drying process and an annealing process. This makes it possible to avoid producing voids in the pattern or deforming the pattern shape, and can achieve a detailed pattern with low internal stress. It will be noted, however, that the annealing process is not required if sufficient *solidification* is possible at a drying temperature of, for example, 80° to 120°C. Yet further, the drying process can be omitted if the process can start at a high temperature without causing any problems.

[Para. 0046] By supplying the liquid pattern material to pattern forming openings in the mask, and *drying and annealing it to solidify*, the present invention thus comprised can easily form a pattern without using vacuum equipment**....**
[Para. 0069] ... the liquid pattern material can be solidified by heating. If the liquid pattern material is solidified by heating, chemicals and expensive equipment are not needed ... Heat solidification of the liquid pattern material can comprise a drying process for evaporating solvent in the liquid pattern material, and an annealing process for annealing the solute. The occurrence of voids can be prevented, and a detailed pattern

with low internal stress and good shape precision can be formed, by thus annealing after drying the liquid pattern material.

[Para. 0090] The solidification unit comprises a heating means disposed in the pattern material supply unit for heating and solidifying the liquid pattern material. ... .

[Para. 00152] The pattern material setting unit 500 can be comprised as a heating chamber or as a tunnel oven... *for heating and solidifying the liquid pattern material 312* in the pattern forming openings. The pattern material setting unit 500 could also be configured to solidify the liquid pattern material 312 using an infrared heater or laser beam or electron beam emissions. ...

[Para. 00172] ... solute contained in the liquid pattern material supplied to the pattern forming openings is annealed in the pattern material setting unit 500 shown in Fig. 1 to complete the *solute solidification process* (step S106). ... .

<u>Dependent Claim 13</u>

Dependent Claim 13, which depends from claim 12, recites:

wherein heating and solidifying the liquid-pattern material comprises a drying process for evaporating solvent in the liquid pattern material, and an annealing process for annealing the dried solute.

[0040] Heating and solidifying the liquid pattern material can as necessary comprise a drying process and an annealing process. ... .

[00170 - 00172] The liquid pattern material 312 supplied to the pattern forming openings is then dried (step S104). Evaporating solvent contained in the liquid pattern material 312 is the main objective of drying the liquid pattern material 312, ... A mask removal step is performed next (step S105). ... After removing the mask, solute contained in the liquid pattern material supplied to the pattern forming openings is annealed in the pattern material setting unit 500 shown in Fig. 1 to complete the solute solidification process (step S106). This pattern annealing step is normally conducted by heating the workpiece 20 to a higher temperature, such as 150°C or higher, than used in the pattern drying process.

[00191 - 00192] Next, liquid pattern material 312 is supplied to the pattern forming openings of the mask as described above in the pattern material supply process of step S142. ... When the first pattern material supply process is completed, the pattern material drying process is applied to evaporate the solvent in the liquid pattern material (step S143). ... Once the last pattern material supply process, pattern material drying process, and dried solid removal process are completed, processing moves to the pattern annealing process shown in the next step S145 to anneal solutes contained in the liquid pattern material 312, complete the solidification reaction, and remove the mask as described above (step S146).

[Para. 00180] The pattern drying process of step S123, which is a pattern material heating and solidification process, and the pattern annealing process (anneal process) of step S124, are then performed. The pattern material drying process heats the workpiece 20 to 80° to 120°C, for example, *to vaporize solvent in the liquid pattern materia*l supplied to the

> pattern forming openings. The pattern annealing process normally uses a temperature above that of the drying process, heating the workpiece 20 to a temperature, such as 150° to 220°C, that will not carbonize a mask made from a resist film, heating solute contained in the liquid pattern material 312 to a higher temperature *and completing the solidification reaction*. The drying and annealing processes can be accomplished by the heater 326 shown in Fig. 4, or by introduction to the special pattern material setting unit 500 shown in Fig. 1. To prevent oxidation of the pattern material, the drying and annealing processes are preferably accomplished in an inert atmosphere such as nitrogen.

<u>Dependent Claim 14</u>

Dependent Claim 14, which depends from claim 1, recites:

wherein the mask is removed from the workpiece after solidifying the liquid pattern material. (See Fig. 9, for example)

<u>Dependent Claim 15</u>

Dependent Claim 15, which depends from claim 1, recites:

wherein the liquid-pattern material is solidified after removing liquid-pattern material that adhered to the mask surface when the liquid-pattern material was supplied to the pattern-forming openings. (see Figs. 7, 13, 14, and 17, for example)

> **[00168 - 00171]** Once the liquid pattern material 312 is supplied to the pattern forming openings, compressed air is discharged from the air knife 330 in an adherent liquid removal step for *removing the liquid pattern material adhering to the mask surface* (step S103). However, this adherent liquid removal step could alternatively be accomplished by spinning the workpiece 20 at high speed by means of the motor 320 shown in Fig. 4 to remove the liquid pattern material 312 adhering to the mask surface by means of centrifugal force, or by tilting the workpiece 20. Yet further, the adherent liquid removal step could be accomplished by operating the air knife 330 while spinning the workpiece 20 or inclining the workpiece 20.
>
> **[00169]** Unnecessary pattern material can thus be easily removed by removing liquid pattern material 312 adhering to the mask surface at the stage *at which the liquid pattern material is supplied to the pattern forming openings*. It is therefore possible to eliminate a step for removing solidified pattern material that is difficult to remove after the liquid pattern material is solidified in a drying process, described below, and the mask can therefore be easily removed. Note that when the liquid pattern material is supplied directly to the pattern forming openings by the above-noted specific-volume discharge device, the adherent liquid removal step of step S103 can be omitted.

> **[00170]** The liquid pattern material 312 supplied to the pattern forming openings is then dried (step S104). <u>Evaporating solvent contained in the liquid pattern material 312 is the main objective of drying the liquid pattern material 312</u>, and is normally achieved by heating the workpiece 20 to 80° to 120° C. The workpiece drying process can be accomplished using the heater 326 built in to the process table 318 shown in Fig. 4, or with a tunnel oven, infrared heater, or laser, not shown in the figures. The pattern material drying step is also preferably performed in an inert atmosphere, such as a nitrogen atmosphere, to prevent pattern oxidation. Of course, the drying step could be performed in an oxidizing atmosphere if oxidizing the pattern is not a problem or if oxidation is preferable.

> **[00171]** A mask removal step is performed next (step S105). This mask removal step can be accomplished by immersing the workpiece 20 in a solution able to dissolve the resist film similarly to a conventional semiconductor device manufacturing process. The mask removal step can alternatively be accomplished immersing the workpiece 20 in ozonated water or other functional solution, or by ashing a mask made from a resist film using a supercritical fluid. Moreover, the mask removal step could drip a resist removal fluid onto the spinning workpiece 20 while the workpiece 20 is rotated as in a spin etching process. Yet further, the mask removal step could be accomplished by ashing with active oxygen generated by emitting an ultraviolet beam or electron beam into oxygen or ozone, or by an electrical discharge into oxygen or ozone at atmospheric pressure.

<u>Dependent Claim 16</u>

Dependent Claim 16 (Fig. 7), which depends from claim 6, recites:

wherein the annealing process (S106) is performed after removing the mask from the workpiece (S105).

<u>Dependent Claim 17</u>

Dependent Claim 17 (Fig. 9), which depends from claim 6, recites:

wherein the mask is removed from the workpiece (S125) after the annealing process (S124).

<u>Dependent Claim 18</u>

Dependent Claim 18 (Fig. 10), which depends from claim 2, recites:

wherein the process for removing the mask and the annealing process are performed simultaneously (In step S133, the mask removal process as well as the heating and solidifying process are combined).

> **[0044]** ... removing the mask and annealing the solute can be accomplished simultaneously by forming the mask from a material with a high breakdown temperature. ....

Independent Claim 19

The present invention, as recited in independent claim 19, is further directed to a pattern forming method (Fig. 11) characterized by:

a mask forming process for forming a mask having pattern-forming openings on a workpiece surface (S140, Para. [00190]);

a pattern material supplying process for supplying a liquid-pattern material to the pattern-forming openings (Para. [00191]) while also drying the liquid-pattern material (S142 with "Simultaneous Drying");

> **[00191]** ...Note that the pattern material drying process can be omitted as indicated by the dotted line if in the pattern material supply process the liquid pattern material 312 is supplied to the pattern forming openings while heating the workpiece to an appropriate temperature.

an annealing process for annealing dried solute of the liquid-pattern material (S145, Para. [00192]); and

a process for removing the mask from the workpiece (S146, Para. [00192]).

Independent Claim 20

The present invention, as recited in independent claim 20, is further directed to a pattern forming method (Fig. 9) characterized by:

a mask forming process for forming a mask having pattern-forming openings on a workpiece surface (S120, Para. [00179]);

a pattern material supplying process for supplying a liquid-pattern material to the pattern-forming openings (S122, Para. [00179]);

a drying process for evaporating solvent in the liquid-pattern material (S123, Para. [00180] and Para. [00181]);

an annealing process for annealing dried solute in the liquid-pattern material (S124, Para. [00180] and Para. [00181]); and

> **[00180]** ...The pattern material drying process heats the workpiece 20 to 80° to 120°C, for example, to vaporize solvent in the liquid pattern material supplied to the pattern forming openings. The pattern annealing process normally uses a temperature above that of the drying process, heating the workpiece 20 to a temperature, such as 150° to 220°C, that will not carbonize a mask made from a resist film, heating solute contained in the liquid pattern material 312 to a higher temperature and completing the solidification reaction. ...

a mask removal process for removing the mask from the workpiece (S125, Para. [00183]).

Independent Claim 21

The present invention, as recited in independent claim 21, is further directed to a pattern forming method (Fig. 7 and/or Fig. 14) characterized by:

a mask forming process for forming a mask having pattern-forming openings on a workpiece surface (S100);

a pattern material supplying process for supplying a liquid-pattern material to the pattern-forming openings (S102);

an adherent-liquid removal process for removing liquid-pattern material that adhered to the mask surface when the liquid-pattern material was supplied to the pattern-forming openings (S103);

a drying process for drying by evaporating solvent in from liquid-pattern material in the pattern-forming openings (S104);

a mask removal process for removing the mask from the workpiece after sequentially performing plural times the pattern material supply process, adherent-liquid removal process, and drying process (S104 of Fig. 7 and S171-S173 of Fig. 14)); and

an annealing process for annealing the dried solute (S106).

> **[0004]** Semiconductor devices are manufactured by repeatedly performing film formation and film patterning operations. Fig. 33 and Fig. 34 are process diagrams showing an example of a conventional patterning process.
>
> **[00199]** Fig. 13 is a flow chart of a seventh pattern forming method according to the present invention. The pattern forming method of this embodiment is used when pattern forming openings are already disposed on the surface of the workpiece 20, such as in combination with conventional processes. The mask forming process is therefore omitted in this seventh pattern forming method.
>
> **[00205]** Fig. 14 is a flow chart of an eighth pattern forming method according to the present invention. The pattern forming method of this embodiment is also applied when pattern forming recesses are also disposed to the workpiece 20. This eighth pattern forming method first hydrophobic processes the surface of the workpiece 20 (step S170). This workpiece 20 hydrophobic process is as described previously.
>
> **[00208]** By thus supplying the liquid pattern material to the pattern forming recesses a small amount at a time, and repeating the pattern material supply and pattern material drying steps, the formation of voids when the pattern material dries can be prevented, and a detailed pattern with low internal stress can be formed. Moreover, because unnecessary liquid pattern material adhering to the workpiece surface is removed before drying the liquid pattern material 312, excess material adhering to the workpiece 20 surface can be removed more easily than when dried material is removed.

<u>Independent Claim 22</u>

The present invention, as recited in independent claim 22, is further directed to a pattern forming method (Fig. 11), comprising:

a mask forming process for forming a mask having pattern-forming openings on a workpiece surface (S140);

a pattern material supplying process for supplying a liquid-pattern material to the mask openings (S142);

a drying process for drying by evaporating solvent from the liquid-pattern material in the pattern-forming openings (S143);

a solid-material removal process for removing dried solids of the liquid-pattern material that adhered to the mask surface when the liquid-pattern material was supplied to the pattern-forming openings (S144);

a mask removal process (S146) for removing the mask from the workpiece after sequentially performing plural times the pattern material supply process, drying process, and solid-material removal process (S142-S144); and

an annealing process for annealing the dried solute (S145).

It is noted that in Fig. 11, mask removal S146 is shown after the annealing process S145, it should noted that the sequence of these two steps is described as design a choice based on the materials used in the patter supply process S142 and in the mask forming process S140. This is explained at least in paragraphs **[00276]** and **[00277]**, as follows.

[00276] The pattern film is then annealed and the mask 656 removed. The annealing temperature of the pattern film 660 and the carbonization temperature of the resist are first compared. *If the carbonization temperature of the resist film forming the mask 656 is higher than the annealing temperature of the pattern film 660, the pattern annealing process follows the drying process.*

[00277] However, *if the carbonization temperature of the resist film is lower than the annealing temperature of the pattern film 660*, the resist film (mask 656) will carbonize during the annealing process and removing the mask 656 will be difficult. In this case, therefore, *the mask removal process is performed first and then the pattern annealing process is performed.* It should be noted that because the carbonization temperature of PMMA, a typical resist, is approximately 260°C, and the annealing temperature of an ITO film is 500°C or higher, the resist removal process is performed first and then the annealing process is performed.

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Claims 1-22, are rejected under 35 U.S.C. §102(b) as being anticipated by EP0630044 A2 (Okumura et al., hereinafter referred to Okumura).

ARGUMENT

Claims 1, 10, 11, 12, 13, 14, 15

In paragraph 2 of the Final Office Action, the Office Action sets forth its rejection of Claims 1-22 under 35 U.S.C. §102(b) as being anticipated by Okumura. Specifically, it is asserted that all features of the present invention, are shown in Okumura's: abstract; col. 2, lines 24-57; col. 3, lines 14-58; col. 4, lines 1-56. Responses to some previously submitted applicant's arguments are listed in paragraph 3.

In as much as these rejections are applied to all claims 1-22, they will be primarily address in this argument section of claims 1, 10, 11, 12, 13, 14, 15, with the understanding that similar arguments may be applied in to argument sections of other claims. Further detailed discussion of some aspects of the Office Action rejections are elaborated upon in other argument sections for other claims, as they may be of particular relevance to those claims.

In reference to paragraph 2 of the Office Action, it is stated,

> "immersing the substrate with openings to a predetermined solution to fill the opening with the material (solidified liquid pattern material, drying the liquid solution adhered onto the opening so as to form a layer in the opening, the SOG layer or SiO2 layer is solidified, palladium layer (electrically conductive layer) formed in the openings)"

Applicants contend that Okumura does not show solidifying a solution, and particularly does not show solidifying a solution by means of a first heat-dry step (to produce solute by evaporation) followed by an annealing step. To better illustrate this, it may be helpful to discuss the relevant text of each of the cited Okumura citations noted above.

In regards to Okumura's abstract, the relevant text appears to be the seventh and tenth paragraphs of the abstract, which state,

<u>Okumura Abstract, paragraphs 7 and 10,</u>

> "... immersing the substrate having the first patterned layer into a predetermined solution *to form a <u>fourth layer</u>* (45)

> selectively over the portions of the second layer uncovered by the first pattern layer; and
>
> ... characterized in that the first layer (41) is an insulating layer, the second layer (42) is a metal layer, third layer (43) is a photoresist layer, and *the fourth layer is a* SiO_2 *layer*, whereby the remainder of the second layer (42) constitutes a metal interconnect layer for the second semiconductor device.

As is stated in paragraph 7, the fourth layer (45) is formed by immersing the substrate into a predetermined solution, and as it is explained in paragraph 10, the fourth layer is a SiO2 layer, which is an *insulator*, not a *conductor* as is required in the presently claimed invention. Thus it is self-apparent that the "predetermined solution" is not, and does not, precipitate a conductive material, in direct contradiction to at least claim 1. As it will be further explained below, the SiO2 is not formed by solidifying the "predetermined solution", but by reacting H2SiF6 with H2O. The point is that the solution is not solidified, and remains in a solution form even after formation of the SiO2 layer. That is, the solution is subject to a chemical reaction that grows a layer of SiO2 on exposed surfaces of the second layer (i.e. metal layer 42). The abstract does not teach or suggest that the solution is solidified, and especially does not teach or suggest that the solution is solidified by application of a first heat-dry step to create dry solute by evaporation, followed by a heat anneal step to finish solidifying the dried solute.

The next cited Okumura excerpt, col. 2, lines 24-57, describes Okumura's use of the grown layer of SiO2 as a mask to etch a metal layer (31, see Okumura Figs. 3A-3D) into separate conductive traces (31a, 31b, and 31c, see Fig. 3D). In the present case, the relevant text is the 10^{th} paragraph in col. 2 (i.e. col. 2, lines 37-50), reproduced herein for convenience.

Okumura, col. 2, lines 37-50

> " Next, the substrate 30 is immersed into a silicofluoride aqueous solution. In this step, a silicon oxide (SiO2) layer 35 of about 1000 Å. is selectively formed at the area where the tungsten silicide (WSi) layer 31 is exposed, since the H2SiF6 and H2O react to precipitate SiO2. To selectively form the SiO2 layer, the surface of the photoresist layer 33a and 33b are subjected to, e.g., an oxygen plasma, to change the surface thereof from a hydrophilic condition (having, e.g., -

> OH radical as an end radical) to a hydrophobic condition (having, e.g., -0 radical as an end radical), preferably. (FIG. 3B) This process is referred to as a hydrophobic treatment hereafter."

As is clear from the above, the aqueous solution contains H2SiF6 and H2O and chemically reacts to grow, i.e. precipitate, on exposed tungsten silicide (Wsi) layer 31 a layer of SiO2. As it would be understood by one versed in the art, this reaction may be express as follows:

$$H_2SiF_6\,(aq)\ +\ 2H_2O\ \rightleftarrows\ Si0_2\,(s) + 6Hf\,(aq)$$

There are several points to be made. Firstly, it is self-evident that Okumura's solution is not "solidified", as is required in the present invention. That is, Okumura's solution remains a solution after the chemical reaction is complete, albeit in a chemically altered form. Furthermore, it cannot be sustained that the solid that is grown by the chemical reaction, i.e. SiO2, is a solidified form of the aqueous solution (H2SiF6 and H2O) since SiO2 is chemically different from the aqueous solution. Secondly, since SiO2 is an insulator, it is likewise self-apparent that the solution is not, and does not, precipitate a conductive material. Thirdly, Okumura does not teach or suggest that his aqueous solution is solidified by drying the solution to precipitate a dried solute, that is subsequently annealed into a high quality solid trace (i.e. conductor layer).

<u>Okumura col. 3, lines 14-58</u>

The present Office Action further assert that the present invention is taught in Okumura col. 3, lines 14-58. In the present case, the relevant text is col. 3, lines 16-43, which state:

> " FIGS. 4A to 4D are cross sectional views for explaining a second embodiment of the present invention. On a semiconductor substrate 40, a thermal oxide layer 41 is formed. On the oxide layer 41, an aluminium layer (A1) 42 of about 8000 Å. to be etched is formed by, e.g., sputtering. Then, a patterned photoresist pattern 43 of about 12,000 Å is formed on the A1 layer 42 using a conventional exposure and development technique. <u>Next, a glass layer 44 is formed by a Spin on Glass (SOG) method *following a baking treatment*.</u>

> (FIG. 4A) Then, a conventional etching process is carried out to remove the relatively thin glass layer formed on the photoresist 43, and to leave a portion of the relatively thick glass layer 44 formed where the photoresist layer 43 is not formed. <u>Next, a hydrophobic treatment is carried out</u>.
>
> <u>Then, the substrate is immersed into a silicofluoride aqueous solution to form a SiO2 pattern 45 of about 2000 Å on the glass layer 44, selectively</u>. (FIG. 4B)
>
> Next, the photoresist pattern 43 is removed by, e.g., a wet etching. (FIG. 4C)
>
> Then, an anisotropic etching, e.g., a RIE, is carried out to form a desired A1 wiring layer 42a and 42b using the SiO2 pattern 45 as a mask. (FIG. 4D) Then, an etching for removing the SiO2 layer 45 and the glass layer 44 is carried out (not shown)."

The Office Action asserts that this excerpt teaches a spin-on-glass, SOG, process where the glass is solidified by applying heat, i.e. in view of the baking treatment. Applicants had pointed out in a previous Office Action Response that in an SOG process, molten glass is typical placed on a silicon wafer (or other substrate), while the wafer is being spun so as to allow centrifugal force to evenly distribute the molten glass over the wafer and form a glass layer. As it is further known in the art, molten glass is solidified by *cooling*, <u>not</u> by *heating*. Indeed Okumura makes sure to note that his SOG process step <u>*follows*</u> a baking treatment, so as to assure that baking temperatures are not applied to the solidified glass, otherwise the solidified glass would melt.

In a telephone interview with Examiner Chako-Davis, Applicants pointed out to the Examiner that the present invention teaches applying a heat treatment to the supplied liquid pattern material, and further teaches that the liquid pattern material is solidified by the application of heat. That is, the present invention teaches solidifying the liquid pattern material by first applying heat to produce a dried solute by evaporation, and then applying heat to anneal the dried solute. Examiner Chako-Davis, however, contended that unless otherwise specified in the claims, the order of claim process steps may be rearranged to recreate the prior art, and thus the Examiner could place the claimed heat dry step prior to the step of supplying the liquid-pattern material. Applicants vehemently disagree since the order of the process steps is not only

suggested by the order in which they are recited, but is strictly encoded into the text of the process steps by virtue of each current process step referencing a previous process step. For example, the presently claimed process steps cannot be rearranged so as to execute a claimed heat-dry step for drying supplied liquid pattern material prior to executing a claim process step for supplying of the liquid pattern material in the first place: otherwise there would not be any liquid pattern material to be dried by the claim heat-dry step. Thus, Applicants reassert the position that it is inappropriate to rearrange the sequence of claim process steps in such a manner so as to contradict claim language or to render nonsensical the claimed invention.

Thus, it is clear that the molten glass in Okumura's SOG process does not read on the liquid pattern material of the present invention: firstly because it is not solidified by heat drying and/or heat annealing; secondly because it is an insulator, and not a conductor (as required by at least claim 1); thirdly because no dried solute is precipitated from the glass by evaporation; and fourthly because Okumura does not teach or suggest an SOG process where glass is distributed within a mask, and the glass is annealed *after* the mask is removed (this would re-melt the glass).

As it is further noted in the above excerpt (Okumura col. 3, lines 16-43), the SOG process is a preliminary process step in preparation for the growth of SiO2. After the glass has been formed in the mask openings, Okumura explains that the mask is subjected to a hydrophobic treatment, and the substrate is then "immersed into a silicofluoride aqueous solution to form to form a SiO2" in areas not covered by the mask. As is explained above, this process of growing SiO2 though a reaction of H2SiF6 and H2O does not read on the present invention because: (1) the aqueous solution is not solidified, but rather remains a aqueous solution; (2) the aqueous solution is not solidified by heat evaporation and heat annealing; (3) the precipitated solid SiO2 is chemically distinct from the aqueous solution and is therefore not a solidified form of the aqueous solution; and (4) the precipitated solid is an insulator, not a conductor.

Okumura col. 4, lines 1-56

It is noted that Col. 4, lines 1-56 encompasses two complete process examples. The first, found in col. 4, lines 7-32, is substantially similar to the example of col. 3, lines 14-58 discussed immediately above. As is explained above, neither the application of a baking treatment *followed* by a spin-on-glass step (col. 4, lines 13-14), nor the application of a SiO2 growth step by reacting H2SiF6 and H2O (col. 4, lines 18-21) teach or suggest the present invention.

The second process example is found in col. 4, line 33 to col. 5, line 19 in reference to Figs. 6A-6D. In the present case, the relevant text is col. 4, lines 33-50 and col. 5, lines 17-19, reproduced herein for convenience.

> " FIGS. 6A to 6D are drawings for explaining a fourth embodiment for forming a contact hole in a semiconductor device. On a semiconductor substrate 60, and insulating layer 61 is formed. Then, a polysilicon layer 62 of about 300 Å is formed on the insulating layer by, e.g., a low pressure CVD method. Next, a patterned photoresist layer 63 is formed on the polysilicon layer 62 using a conventional exposure and development technique. (FIG. 6A) *Then, a hydrophobic treatment of the photoresist layer 63 is carried out.*
> Next, the substrate is immersed into a solution of palladium chloride (PbC12) to form a palladium layer 64 of less than 100 Å *using a electroless plating method*. Next, the substrate is immersed into a mixed solution of nickel sulfate (NiSO4) and hypophosphite to form a nickel layer 65 of about 1000 Å. (FIG. 6B) ...
> ... *The palladium layer 64 provides a good adhesion between the polysilicon layer 62 and the nickel 65.*"

In this example, Okumura shows forming a via using nickel electroless plating. Specifically, Okumura shows a two-step electroless plating process wherein a first electroless plating process for forming a thin palladium layer 64 is followed by a second electroless plating process for forming a nickel layer 64 on the palladium layer 64. As Okumura explains immediately above, the "palladium layer 64 provides a good adhesion between the polysilicon layer 62 and the nickel 65." In other words, nickel may not plate well onto polysilicon, and an intermediate material, or activation layer, that adheres well to (i.e. react well with, or is catalytic to) polysilicon and to nickel is placed between the polysilicon and the nickel. As it would be understood, this activation material is palladium in Okumura's example.

In a previous Office Action response, Applicants had pointed out that electroless plating is not equivalent to solidifying a liquid-pattern material, and is particularly not equivalent to solidifying a liquid by a first heat-drying step to produce dried solute followed by an annealing step. This is particularly true since an electroless plating process produces byproducts that are released into the solution such that the solution is not solidified at the end of electroless plating process. That is, the solution remains a solution, but in a chemically altered form. Furthermore, the plated layer (i.e. palladium or nickel) is chemically different from the solutions from which they are extracted (i.e. solutions of palladium chloride (PbC12) or solutions of nickel sulfate (NiSo4), respectively). Since a plated solid is different from the solution from which it is extracted, the plated solid cannot be said to be a solid form of the solution.

In the aforementioned telephone interview with Examiner Chako-Davis, it was pointed out that Okumura's palladium layer 64 is constructed by electroless plating in a palladium chloride solution. Examiner Chako-Davis appeared to agree that electroless plating is not equivalent to solidifying a liquid-pattern material (particularly solidifying by producing dried solute through evaporation). However, in the present Final Rejection, the Office Action sites the formation of nickel layer 65 from a solution of nickel sulfate as being equivalent to the presently claimed solidified liquid pattern material. It would appear that the Office Action is not convinced that the nickel layer is the result of an electroless plating process, in the same manner as the palladium layer is the result of electroless plating. However, Okumura himself, in col. 7, lines 43-47, explains that nickel layer 65 in the example of Fig. 6 is formed by electroless plating (i.e. a non-electric plating process). Specifically, Okumura states:

> " In the examples of Figures 3, 4, 5 and 7, a SiO2 layer formed by a precipitation is used as a mask layer. However, it is possible to use <u>a nickel layer *formed by an non-electrical plating process, as used in Fig. 6*</u>, as a mask layer, and vice versa. Thus, in each embodiment, either a SiO2 layer or a nickel layer may be used as the mask layer."

Thus, applicants assert that Okumura's nickel electroless plating process does not read upon the present invention's requirement of solidifying a liquid at least

for similar reasons as Examiner Chako-Davis agreed that electroless plating in a palladium chloride solution does read on the present invention.

In paragraph 3 of the Final Office Action, responses A to D to previously submitted arguments are provided. It is believed that applicant's position has been clarified above. In regards to item (D), however, it is noted that the Office Action asserts that:

> "Okumura, in col. 3, lines 16-32, discloses that spin-on-glass material is formed (spray or spin coating the spin-on-glass liquid material) in the openings of the photoresist mask, <u>followed by baking</u>. Baking involves evaporating as well as annealing since baking involves heating to high temperatures."

Applicants respectfully note that in "col. 3, lines 16-32" Okumura does not disclose that a spin-on-glass process is followed by baking. As is explained above, this would result in re-melting the glass layer and thus render Okumura's process inoperable. Rather Okumura states in col. 3, lines 23-25 that, "...glass layer 44 is formed by a Spin on Glass (SOG) method <u>following</u> a baking treatment." As is clear from this quote, Okumura explains that his SOG process <u>follows</u> his baking treatment, and does not precede it.

Further in response to the assertion that baking encompasses both drying and annealing, since it has been shown that Okumura's baking step precedes his SOG step, combining of the drying and annealing steps into Okumura's baking step still does not achieve the present invention. Nonetheless, Applicants feel compelled to explain that while it is true that if baking is conducted at a sufficiently high temperature, one may achieve both drying and annealing, but such is not always practical, or optimal, and may result in an inferior product. This is explained at least in paragraph 00173 of the specification of the present invention, wherein it states:

> **[Para. 00173]** ... Moreover, because the liquid pattern material 312 is annealed in the pattern annealing process <u>*after*</u> drying in the pattern drying process in this first pattern forming method, the formation of internal voids and the *formation of deformation recesses in the formed pattern surface when the liquid pattern material 312 solidifies can be prevented.*

Thus, applicants contend that it improper to combine separately recited process steps when such a combination would result in a substantially different product. Furthermore, applicants point out that at least claims 2, 3, 5, 6, 8, 9, 16, and 21 require that additional intervening process steps be executed between the heat drying step and the annealing step. It is clear that in such cases, the drying step and annealing steps cannot be combined without omitting the intervening process steps.

Returning now to the specific arguments of Claims 1, 10, 11, 12, 13, 14, 15, claim 1 requires, inter alia, "supplying and <u>solidifying</u> *an electrically* <u>*conductive*</u> *liquid pattern material* in the pattern-forming openings of the mask". As is explained above, Okumura's growth of SiO2 by chemically reacting $H_2SiF_6(aq)$ + H2O and Okumura's electroless (i.e. chemical) plating processes do not solidify a liquid (i.e. their respective aqueous solutions remain in solution form after their production of a solid), nor is the solid that results from their respective chemical reactions a representative form of the solution from which they are extracted. That is, SiO2 is not a solid form of the solution from which it is extracted, silicofluoride aqueous solution (i.e. $H_2SiF_6(aq)$ + H2O); palladium is not a solid form of the solution from which it is extracted, palladium chloride (PbC12); and nickel is not a solid form of the solution form which it is extracted, nickel sulfate (NiSO4) and hypophosphite. This difference is particularly self-evident when one considers that palladium chloride and nickel sulfate are both salts, while palladium and nickel are metals. Thus, none of the solids can be asserted to represent solid forms of (or solidified samples of) the solution from which they were extracted.

In regards to Okumura's use of spin on glass, SOG, since glass is an electrical insulator, it is clear that glass does not read on the claimed "*electrically conductive* liquid pattern material", as would be required by the present rejections under 35 U.S.C. §102(b). Furthermore, since an electrical insulator is directly contrary to an electrical conductor, it is not obvious to replace one for the other.

Dependent claim 12 further clarifies that, "the liquid-pattern material is solidified by applying heat." As is explained above, none of Okumura's process steps teach solidifying an electrically conductive liquid by applying heat.

Dependent claim 13 further clarifies that the electrically conductive liquid pattern material is solidified by applying a first drying step to produce dried solute by evaporation (as it is known in the art, once a solvent has been extracted from a liquid, i.e. a solution, the resultant dried solvent particles are termed a "solute" since they are no longer dissolved in the liquid). This drying step is followed by an annealing step to anneal the dried solute. Since the annealing step anneals solute produced in the drying step, it is clear that the annealing step must follow the drying step. As is further explained above, Okumura is silent on any process for solidifying a liquid (particularly an electrically conductive liquid) by producing dried solute by evaporation, followed by annealing the dried solute.

Claim 15 further explains that, "the liquid-pattern material is *solidified after removing* liquid-pattern material that adhered to the mask surface when the liquid-pattern material was supplied to the pattern-forming openings". As is explained above, the only process that remotely relates to this claim is Okumura's electroless process since it produces a conductive layer. However, as is explained above, the electroless plating process requires that the substrate be immerged in a chemical solution. If the substrate is removed from the solution, then no plating can occur. Therefore, it makes no sense to assert that Okumura teaches that the liquid pattern material is solidified (or that a solid is extracted from a liquid) *after* the substrate is removed from the solution, as would be required in order to remove liquid-pattern material that adheres to the mask surface. Furthermore, Okumura explains that no material adheres to his mask due to it having been made hydrophobic to repel liquid. Additionally, since the mask is chemically inert (as is more fully explained in the last paragraph of the argument section of claim 7), it does not react with the solution.

Claim 2, 18

Claims 2 and 18 require that the liquid pattern material be dried *while* it is being supplied to the pattern-forming opening of the mask. None of Okumura's cited processes teach or suggest such a step. Both of Okumura's processes for producing SiO2 and for electroless plating required that the substrate remain immersed in a solution. In the case of SOG, the glass is solidified heat drying or annealing.

The language of claim 2 does not restrict the application of the annealing step to being after the mask removal step. Therefore, claim 18 teaches that the mask removal step and the annealing step may be executed simultaneously. Okumura does not teach or suggest a combined mask removal and annealing step.

A more thorough discussion of the Okumura reference is found in argument section of claims 1, 10, 11, 12, 13, 14, 15.

Claim 3

Claim 3 clearly recites that after the liquid-pattern material is supplied, it is subjected to "a drying process for evaporating solvent in the liquid-pattern material". As it would be understood, this evaporation process by drying produces the dried solute that constituted the solvent in the liquid-pattern material. After the dried solute has been produced, claim 3 requires removal of the mask, followed by "annealing process for annealing dried solute in the liquid-pattern material." These process steps clearly explain that a solid in the present invention is produced by extracting dried solute from the liquid-pattern material by evaporation, and then annealing the dried solute. Clearly, none of Okumura's cited processes (i.e. formation of SiO2, SOG, or electroless plating) described this method of solidifying a liquid, as is more fully explained in the argument section of claims 1, 10, 11, 12, 13, 14, 15. Furthermore, none of Okumura's cited processes teach or suggest an annealing step *after* the mask has been removed.

Claim 4

Claim 4 describes, "supplying an *electrically conductive* liquid-pattern material to the pattern-forming openings." As is explained in the argument section of claims 1, 10, 11, 12, 13, 14, 15, neither of Okumura's processes for formation of SiO2, or SOG read on claim 4 since both SiO2 and glass are insulators and not electrically conductive.

Furthermore, as is explained above in the argument section of claims 1, 10, 11, 12, 13, 14, 15, Okumura's electroless plating process does not read on the claimed step of solidifying the liquid-pattern material primarily because Okumura's extracted solid is dissimilar to the solution from which it is extracted, and secondly because Okumura's solution is not solidified during the formation of a solid plating material.

Since Okumura does not teach or suggest either of the above two step, it is clear that he does not teach nor suggest their repeated application prior to removal of the mask.

Claim 5

The present invention further teaches two additional steps to be executed *before* solidifying the applied liquid-pattern material. As is recited in claim 5, for example, the present invention requires an "adherent-liquid removal process for removing liquid pattern material that adhered to the mask surface when the liquid-pattern material was supplied to the openings" *before* solidifying the liquid-pattern material. In other words, prior to the solidifying process, any liquid-pattern material not within the openings of the mask is removed. This is clearly in contradiction to Okumura's teaching that the substrate remain immersed in this solution during the growth of SiO2 in order for the formation of SiO2 to take place. If Okumura's substrate were removed from his aqueous solution so as to remove any aqueous solution that adhered to his mask prior to formation of his solid (i.e. SiO2), then no solid could form since no chemical reaction on the substrate can take place outside of the solution.

In other words, both the formation of insulator SiO2 by reacting H2SiF6 with H2O and the formation of a solid through electroless plating require that the substrate remain immerged in a solution during the formation of a solid on the substrate. Since the mask is attached to the substrate, liquid cannot be removed from the mask without also removing the substrate from the solution, which would prevent the forming of a solid on the substrate. As it is further in the last paragraph of the argument section of claim 7, not only does Okumura teach that his hydrophobic treatment prevents liquid from adhering to his mask, the mask is chemically inert to the electroless plating process. Thus Okumura teaches that no liquid adheres to his mask, and thus teaches away from the claimed adherent-liquid removal process.

As is also explained above in reference to the argument section of claims 1, 10, 11, 12, 13, 14, 15, Okumura does not teach a solidifying process consisting of a first drying process to produce dried solute by evaporation, followed by an annealing step for annealing the produced dried solute. It must be emphasized that the claim language states, "annealing *the dried* solute <u>*after*</u> sequentially performing plural times the pattern material supply process, adherent-liquid removal process, and drying process", such that it is not possible to combine the annealing step into the drying step, as is suggested by the Office Action. This is the case not only because of the intervening steps between the drying step and the annealing step, but also because the annealing step references <u>*the*</u> *dried* solute created by the drying step. Thus, the drying step must be implemented prior to the annealing step in order to produce the dried solute required in the annealing step.

It is noted that the Office Action cites Okumura's two plating process (i.e. a first electroless plating process to form a palladium layer followed by a second electroless plating process to form a nickel layer) to read on the present invention's recitation of repeating the steps of providing the liquid pattern material followed by step of solidifying the provided liquid pattern material, prior to a final annealing process step or a mask removal step. Applicants respectfully point out that the claim language require that specific process steps be repeated, and thus the liquid pattern material would be understood to be the

same each time the specific steps are repeated. This is contrary to Okumura's teaching wherein the first solution is palladium chloride to plate a layer of palladium, and the second solution is nickel sulfate to plate a layer of nickel.

Nonetheless, as is explained above in reference to the argument section of claims 1, 10, 11, 12, 13, 14, 15, electroless plating does not read on the presently claimed liquid-pattern material, nor on the process step of solidifying the liquid-pattern material, nor solidifying the liquid-pattern material by a heat drying process to produce solute by evaporation followed by a step to heat annealing the solute. It is further noted that Okumura does not teach or suggest any annealing step ***following*** the formation of a nickel plate layer.

Claims 6, 16, 17

Claim 6 recites a drying process for evaporating solvents from the liquid-pattern material. As it is known, the solvent once dried from a liquid is termed a solute. Thus, claim 6 further recites, "an annealing process for annealing the dried solute after sequentially performing plural times the pattern material supply process and drying process."

As is explained above in the argument section of claims 1, 10, 11, 12, 13, 14, 15, Okumura is silent on any process of producing a solid from a liquid by first producing dried solute by evaporation, followed by annealing the dried solute. Thus Okumura does not teach removing the mask after an annealing process as recited in claim 17.

Claim 16 further requires that the annealing process be performed after removing the mask. Okumura is silent on any process that teaches an annealing step ***after*** a mask removal step.

Claim 7

Claim 7 recites supplying an electrically conductive liquid-pattern material. As is explained above in the argument section of claims 1, 10, 11, 12, 13, 14, 15, this requirement precludes Okumura's growth of SiO2 through a

reaction of H_2SiF_6 with H_2O and precludes Okumura's use of spin-on-glass (SOG) since both SiO_2 and glass are electrical insulators, not conductors.

As is also explained above in the argument section of claims 1, 10, 11, 12, 13, 14, 15, the process of producing solid metal by electroless plating does not read on the claimed process of "solidifying the liquid-pattern material", since electroless plating does not solidify its solution nor is the plated metal a solid form of the solution.

Claim 7 further explains that following the solidifying of the liquid pattern material, the present invention further includes, "a solid-material removal process for removing solidified elements of the liquid-pattern material that adhered to the mask surface *when* the liquid-pattern material was supplied to the pattern-forming openings." Okumura does not teach any such solid-material removal process. Furthermore, Okumura teaches that no solid SiO_2 is formed on his mask surface during his chemical process for growing a SiO_2 layer. Specifically, as is noted in Okumura's col. 2, lines 37-50, Okumura explains that his mask (i.e. photoresist layer 33a and 33b) is made hydrophobic to repel the aqueous solution, and that the SiO_2 grows only on exposed areas of his tungsten silicide (WSi) layer 31. Thus, it is self apparent that Okumura teaches that no SiO_2 (i.e. solid) grows on his mask, and thus no solid-material removal process is taught or suggested by Okumura's process.

Furthermore in reference to Okumura's use of electroless plating, it is known that a benefit of electroless plating is that the deposition process is highly favorable at chemically active surfaces such as silicon and aluminum against chemically inert dielectric surfaces such as silicon dioxide or photoresist. Since chemically inert materials, such as a photoresist mask do not chemically react and hence do not experience plating, it is noted that no solids would adhere to Okumura's photoresist mask in an electroless plating process, and thus there would not be any need for a subsequent solid-removal step for removing solids from Okumura's mask. Basically, since Okumura's mask material is chemically inert so that no solids form on it during Okumura's electroless plating process,

no "solid-material removal process" is suggested as part of Okumura's electroless plating process.

In the present invention, however, since the solid is formed by producing dried solute by evaporation, it may occur that solid, solute particles may adhere to the mask which where previously repelled from the mask when the particles were a solvent in liquid due to the mask having been made hydrophobic.

Lastly, it is clear that Okumura does not teach or suggest repeated applications of "the pattern material supply process, solidifying process, *and solid-material removal process*" prior to removing the mask since Okumura's mask must remain submerged in solution in order for any solid growth to occur, as is more fully explained in the arguments addressing claim 1.

Claim 8

Like claim 7, claim 8 recites a drying process to produce solute by evaporation, and recites a solid-material removal process for removing solids that adhered to the mask surface. As is explained in the argument section of claim 7, above, Okumura does not teach or suggest these process steps.

Claim 8 further recites an annealing step for annealing the dried solute, "after sequentially performing plural times the pattern material supply process, drying process, solid-material removal process." As is also explained in the argument section of claims 1, 10, 11, 12, 13, 14, 15, Okumura is silent on any step for annealing dried solute produced from a liquid by evaporation using a drying process.

Claim 9

Like claim 8, claim 9 recites producing dried solute from a liquid-pattern material through evaporation by means of a drying process, and recites a solid-material removal process followed by a step for annealing the dried solute.

Claim 9, however, further requires that the mask not be removed until, "sequentially performing plural times the pattern material supply process, drying process, solid-material removal process, and annealing process". Since Okumura does not teach or suggest these individual steps, neither does he teach or suggest their repeated application prior to removal of the mask (see argument section of claim 5).

Claim 19

Claim 19 teaches a combined step of supplying a liquid-pattern material while also drying the liquid-pattern material. As is explained above in the argument section of claim 2, this is not taught or suggested by Okumura.

Claim 19 further recites that the liquid-pattern material is solidified by a heat dry step to produce dried solute by evaporation, and an annealing step for annealing the dried solute. Again, Okumura is silent on any process for producing dried solute by evaporation, and annealing the produced dried solute.

Claim 20

Claim 20 recites a root aspect of the present invention, i.e. that of solidifying liquid pattern material by means of a drying process for evaporating solvent in the liquid-pattern material, followed by an annealing process for annealing dried solute produced by the drying process. As is explained above in the argument section of claims 1, 10, 11, 12, 13, 14, 15, Okumura is silent on any process of solidifying a liquid pattern material by producing dried solute by evaporation, followed by annealing the dried solute.

Claim 21

Claim 21 recites "an adherent-liquid removal process" *prior* to the solidifying steps. As is explained above in the argument section of claims 1, 10, 11, 12, 13, 14, 15, this is contrary to Okumura's process for forming SiO2 and electroless plating process since these processes require that the substrate remain immerged in a solution in order to form a solid on the substrate. Furthermore in regards to SOG, it is self-apparent that the molten glass cannot be removed from the mask prior to solidifying the glass. As it is known in the art, and as is recited by Okumura, after the SOG process, the solid glass is removed from the mask by etching. Okumura does not teach or suggest any step for removing liquid glass from the mask prior to solidifying the glass.

Not only does claim 21 recite the specific method of solidifying the liquid-pattern material as consisting of a drying step for producing dried solute by evaporation and a separate annealing step for annealing the dried solute produced in the drying step, claim 21 further prevents the annealing step from being combined with the drying step by requiring an intervening step of removing the mask after repeating "the pattern material supply process, adherent-liquid removal process, and drying process."

As is explained above in the argument section of claims 1, 10, 11, 12, 13, 14, 15, Okumura is silent on any liquid solidifying process consisting of a drying step for forming dried solute by evaporation followed by an annealing step.

Claim 22

Claim 22 again recites the present method of solidifying a solvent by a first drying step to produce dried solute by evaporation followed by an annealing step for annealing the dried solute. Claim 22, further recites a solid-material removal process for removing dried solids of the liquid-pattern material that adhere to the mask surface when the liquid-pattern material was supplied. As is explained above in the argument section of claim 7, Okumura teaches that no

liquid adheres to his mask, and therefore no solid adhere to his mask. That is, Okumura teaches that no solid adheres to his mask during formation of SiO2 or during his electroless plating process.

Although a solid (i.e. glass) is removed from the mask by etching following the SOG process, the SOG process does not read on the present solidifying method. That is, an SOG process does not solidify glass through an evaporation step to produce dried solute and an anneal step to anneal the dried solute.

Lastly, Claim 22 teaches that the anneal step is separated from the drying step by a mask removal process that is executed only after repeated application of "the pattern material supply process, drying process, and solid-material removal process."

CONCLUSION

It is respectfully submitted that the Examiner seeks to recreate the present invention in the Okumura reference by impermissible rearrangement of claim process steps, reading far more into the prior art than is reasonable, interchanging steps from a prior art insulator forming method (SOG or LPD) into a prior art conductor forming method (electroless plating), overlooking key claim language (such as the meaning of solidifying a liquid), and neglecting claim process steps (such as solidifying a liquid specifically by heat-drying the liquid to produce dried solute by evaporation and then annealing the produced dried solute). The Examiner has failed to meet the burden under the law with regard to showing either anticipation or obviousness of applicants' invention as particularly claimed.

Applicants therefore request that the Board reverse the Examiner's final rejection of Claims 1-22.

Respectfully submitted,

/Rosalio Haro/
Rosalio Haro
Registration No. 42,633

Please address all correspondence to:

Epson Research and Development, Inc.
Intellectual Property Department
2580 Orchard Parkway, Suite 225
San Jose, CA 95131
Telephone: (408) 952-6131
Facsimile: (408) 954-9058
Customer No. 20178
Date: November 2, 2007

CLAIMS APPENDIX

1. A pattern forming method characterized by forming a mask having pattern-forming openings on a workpiece surface, and then supplying and solidifying an electrically conductive liquid pattern material in the pattern-forming openings of the mask.

2. A pattern forming method comprising:

a mask forming process for forming a mask having pattern-forming openings on a workpiece surface;

a pattern material supplying process for supplying a liquid-pattern material to the pattern-forming openings while also drying the liquid-pattern material;

a process for removing the mask from the workpiece; and

an annealing process for annealing dried solute of the liquid-pattern material.

3. A pattern forming method comprising:

a mask forming process for forming a mask having pattern-forming openings on a workpiece surface;

a pattern material supplying process for supplying a liquid-pattern material to the pattern-forming openings;

a drying process for evaporating solvent in the liquid-pattern material;

a mask removal process for removing the mask from the workpiece; and

an annealing process for annealing dried solute in the liquid-pattern material.

4. A pattern forming method comprising:

a mask forming process for forming a mask having pattern-forming openings on a workpiece surface;

a pattern material supplying process for supplying an electrically conductive liquid-pattern material to the pattern-forming openings;

a solidifying process for solidifying the liquid-pattern material supplied into the pattern-forming openings; and

a mask removal process for removing the mask from the workpiece after sequentially performing plural times the pattern material supply process and solidifying process.

5. A pattern forming method comprising:

a mask forming process for forming a mask having pattern-forming openings on a workpiece surface;

a pattern material supplying process for supplying a liquid-pattern material to the pattern-forming openings;

an adherent-liquid removal process for removing liquid pattern material that adhered to the mask surface when the liquid-pattern material was supplied to the openings;

a drying process for drying by evaporating solvent from the liquid-pattern material in the pattern-forming openings;

an annealing process for annealing the dried solute after sequentially performing plural times the pattern material supply process, adherent-liquid removal process, and drying process; and

a mask removal process for removing the mask from the workpiece.

6. A pattern forming method comprising:

a mask forming process for forming a mask having pattern-forming openings on a workpiece surface;

a pattern material supplying process for supplying a liquid-pattern material to the pattern-forming openings;

a drying process for drying by evaporating solvents from the liquid-pattern material in the pattern-forming openings; and

an annealing process for annealing the dried solute after sequentially performing plural times the pattern material supply process and drying process.

7. A pattern forming method comprising:

a mask forming process for forming a mask having pattern-forming openings on a workpiece surface;

a pattern material supplying process for supplying an electrically conductive liquid-pattern material to the pattern-forming openings;

a solidifying process for solidifying the liquid-pattern material supplied into the pattern-forming openings;

a solid-material removal process for removing solidified elements of the liquid-pattern material that adhered to the mask surface when the liquid-pattern material was supplied to the pattern-forming openings; and

a mask removal process for removing the mask from the workpiece after sequentially performing plural times the pattern material supply process, solidifying process, and solid-material removal process.

8. A pattern forming method comprising:

a mask forming process for forming a mask having pattern-forming openings on a workpiece surface;

a pattern material supplying process for supplying a liquid-pattern material to the mask openings;

a drying process for drying by evaporating solvent from the liquid-pattern material in the pattern-forming openings;

a solid-material removal process for removing dried solids of the liquid-pattern material that adhered to the mask surface when the liquid-pattern material was supplied to the pattern-forming openings;

an annealing process for annealing the dried solute after sequentially performing plural times the pattern material supply process, drying process, solid-material removal process; and

a mask removal process for removing the mask from the workpiece.

9. A pattern forming method comprising:

a mask forming process for forming a mask having pattern-forming openings on a workpiece surface;

a pattern material supplying process for supplying a liquid-pattern material to the mask openings;

a drying process for drying by evaporating solvent from the liquid-pattern material in the pattern-forming openings;

a solid-material removal process for removing dried solids of the liquid-pattern material that adhered to the mask surface when the liquid-pattern material was supplied to the pattern-forming openings;

an annealing process for annealing the dried solute; and

a mask removal process for removing the mask from the workpiece after sequentially performing plural times the pattern material supply process, drying process, solid-material removal process, and annealing process.

10. A pattern forming method as described in claim 1, wherein the mask has hydrophobic properties on at least the surface thereof for repelling the liquid pattern material.

11. A pattern forming method as described in claim 1, wherein the mask is hydrophobic for repelling the liquid pattern material.

12. A pattern forming method as described in claim 1, wherein the liquid-pattern material is solidified by applying heat.

13. A pattern forming method as described in claim 12, wherein heating and solidifying the liquid-pattern material comprises a drying process for evaporating solvent in the liquid pattern material, and an annealing process for annealing the dried solute.

14. A pattern forming method as described in claim 1, wherein the mask is removed from the workpiece after solidifying the liquid pattern material.

15. A pattern forming method as described in claim 1, wherein:

the liquid-pattern material is solidified after removing liquid-pattern material that adhered to the mask surface when the liquid-pattern material was supplied to the pattern-forming openings.

16. A pattern forming method as described in claim 6, wherein the annealing process is performed after removing the mask from the workpiece.

17. A pattern forming method as described in claim 6, wherein the mask is removed from the workpiece after the annealing process.

18. A pattern forming method as described in claim 2, wherein the process for removing the mask and the annealing process are performed simultaneously.

19. A pattern forming method comprising:

a mask forming process for forming a mask having pattern-forming openings on a workpiece surface;

a pattern material supplying process for supplying a liquid-pattern material to the pattern-forming openings while also drying the liquid-pattern material;

an annealing process for annealing dried solute of the liquid-pattern material; and

a process for removing the mask from the workpiece.

20. A pattern forming method comprising:

a mask forming process for forming a mask having pattern-forming openings on a workpiece surface;

a pattern material supplying process for supplying a liquid-pattern material to the pattern-forming openings;

a drying process for evaporating solvent in the liquid-pattern material;

an annealing process for annealing dried solute in the liquid-pattern material; and

a mask removal process for removing the mask from the workpiece.

21. A pattern forming method comprising:

a mask forming process for forming a mask having pattern-forming openings on a workpiece surface;

a pattern material supplying process for supplying a liquid-pattern material to the pattern-forming openings;

an adherent-liquid removal process for removing liquid-pattern material that adhered to the mask surface when the liquid-pattern material was supplied to the pattern-forming openings;

a drying process for drying by evaporating solvent in from liquid-pattern material in the pattern-forming openings;

a mask removal process for removing the mask from the workpiece after sequentially performing plural times the pattern material supply process, adherent-liquid removal process, and drying process; and

an annealing process for annealing the dried solute.

22. A pattern forming method comprising:

a mask forming process for forming a mask having pattern-forming openings on a workpiece surface;

a pattern material supplying process for supplying a liquid-pattern material to the mask openings;

a drying process for drying by evaporating solvent from the liquid-pattern material in the pattern-forming openings;

a solid-material removal process for removing dried solids of the liquid-pattern material that adhered to the mask surface when the liquid-pattern material was supplied to the pattern-forming openings;

a mask removal process for removing the mask from the workpiece after sequentially performing plural times the pattern material supply process, drying process, and solid-material removal process; and

an annealing process for annealing the dried solute.

EVIDENCE APPENDIX

N/A

RELATED PROCEEDINGS APPENDIX

N/A